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**Matsumoto**

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(54) **IMAGE FORMING APPARATUS AND  
DETACHABLE UNIT FOR USE THEREWITH**

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**G03G 21/18** (2006.01)

**G03G 15/08** (2006.01)

(52) **U.S. Cl.**

CPC ..... **G03G 21/1867** (2013.01); **G03G 15/0863**  
(2013.01); **G03G 21/1885** (2013.01)

(58) **Field of Classification Search**

CPC ..... G03G 21/1885  
See application file for complete search history.

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(57) **ABSTRACT**

An image forming apparatus includes an apparatus main body and a contact terminal, and a detachable unit including a holder for holding a circuit board having an electrode terminal which comes into contact with the contact terminal. A state of the detachable unit is changed to an attached state by inserting it in an insertion direction, and is changed to a detached state by withdrawing the detachable unit in a withdrawal direction. The holder includes a first positioning member for positioning a tip end of the circuit board in the insertion direction when the detachable unit holding the circuit board in the holder is slid in the insertion direction. The first positioning member includes a notch configured so that the contact terminal passes through the notch when the detachable unit not holding the circuit board in the holder in the attached state is slid in the withdrawal direction.

**19 Claims, 16 Drawing Sheets**

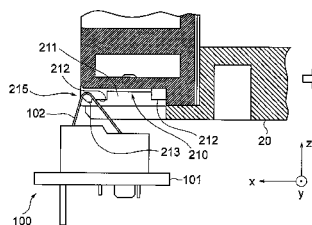
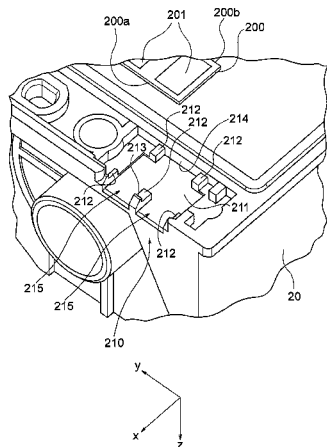


FIG. 1

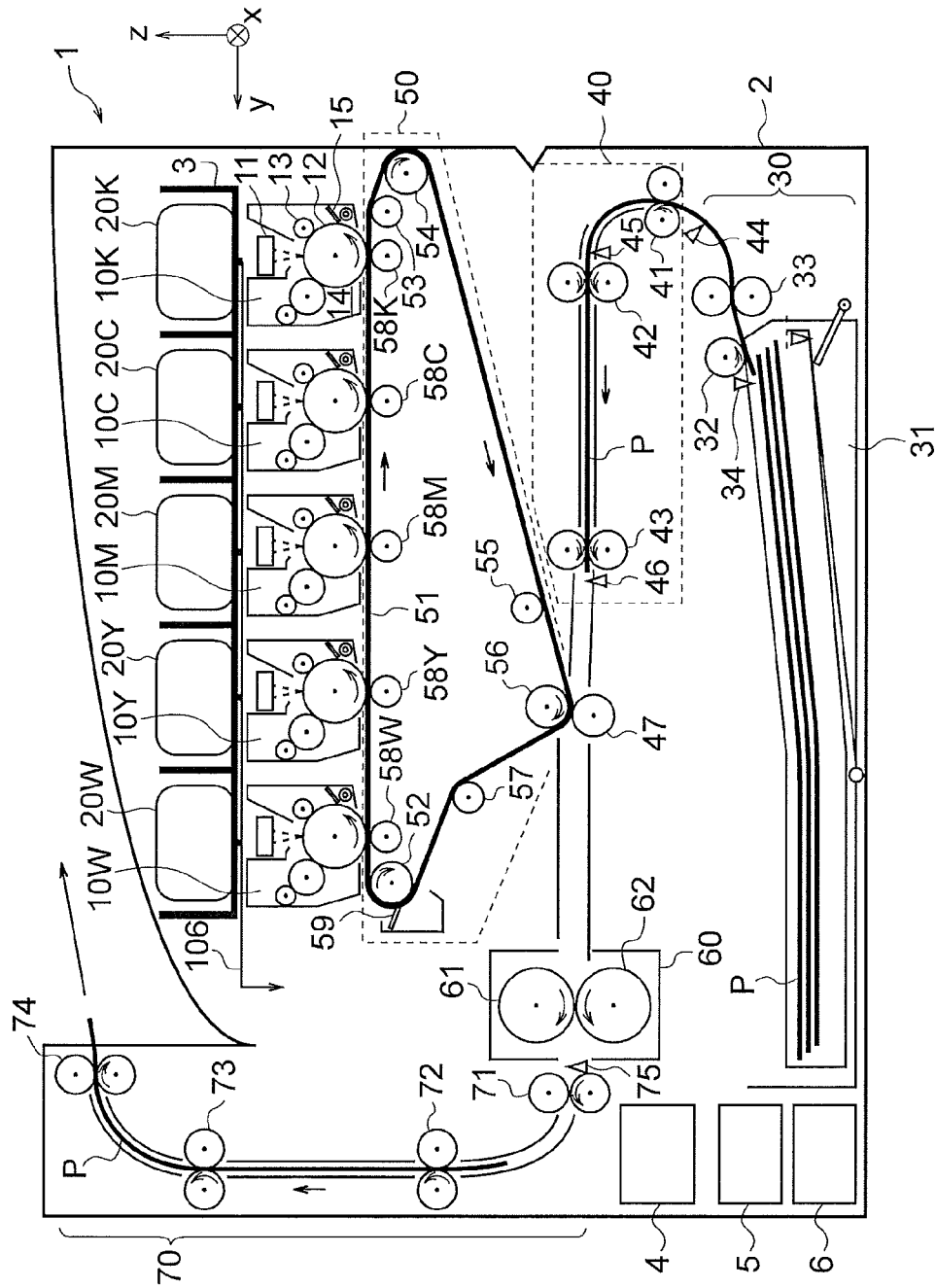


FIG. 2A

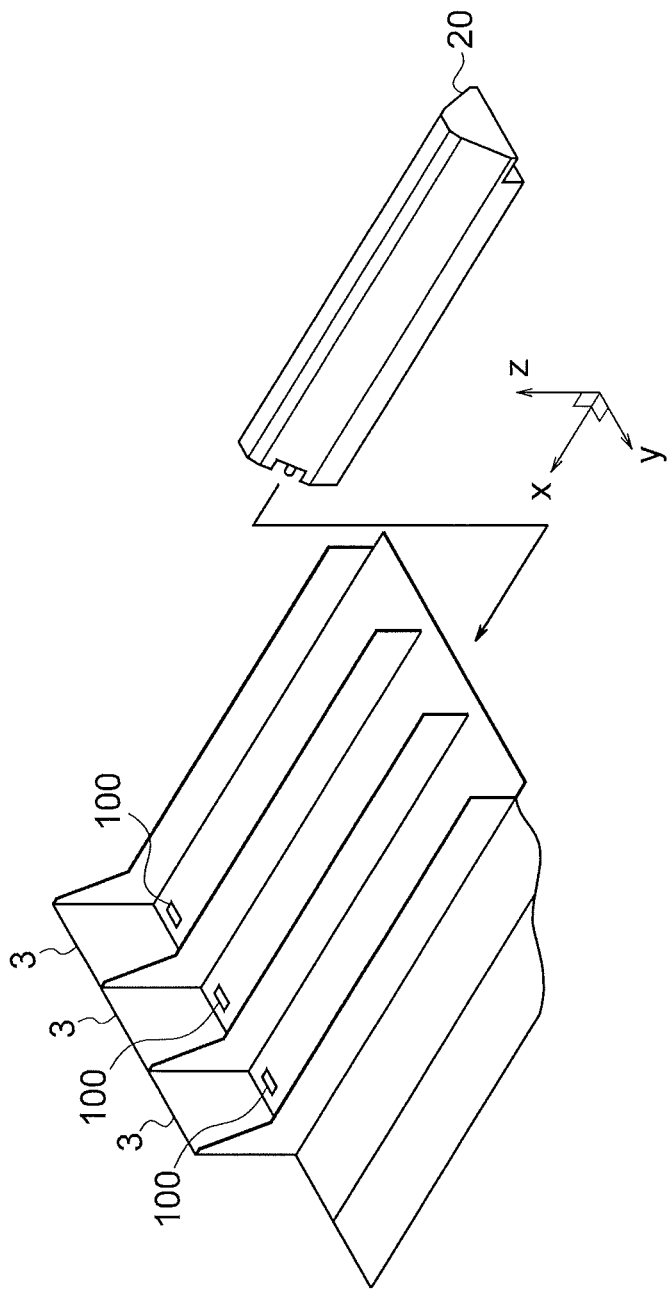


FIG. 2B

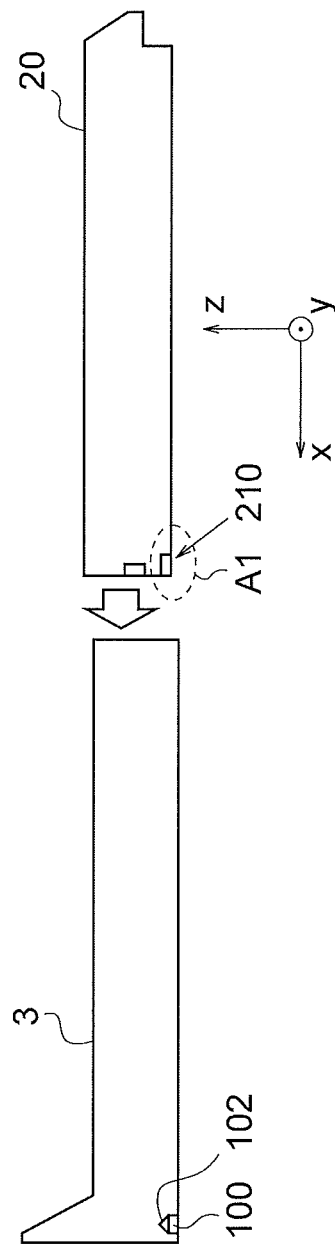


FIG. 3

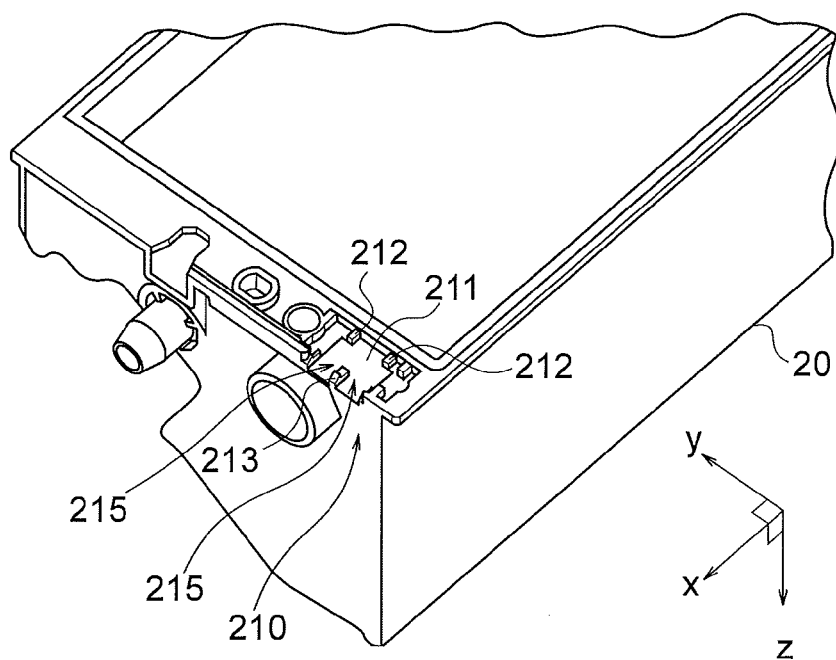


FIG. 4

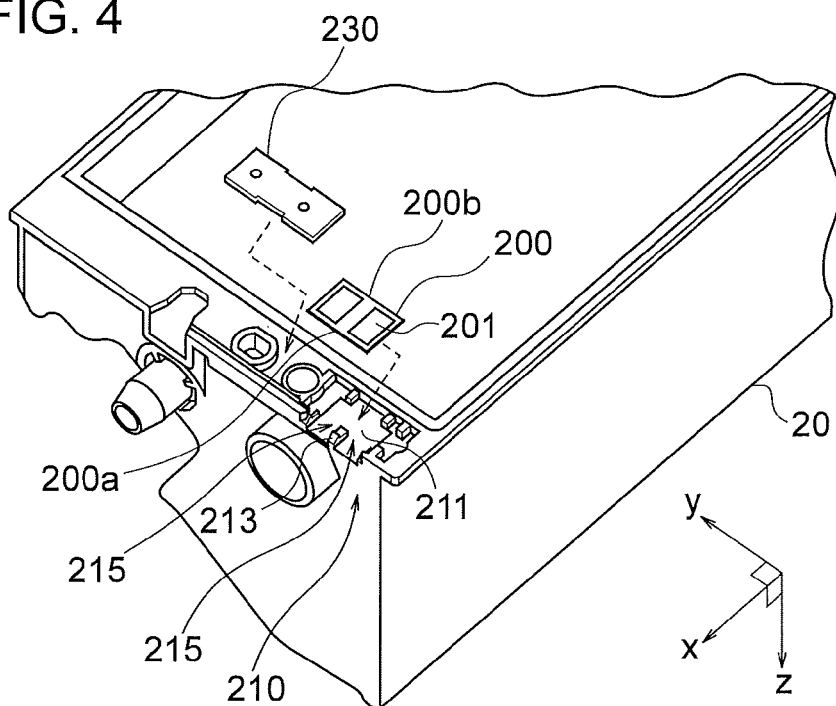


FIG. 5

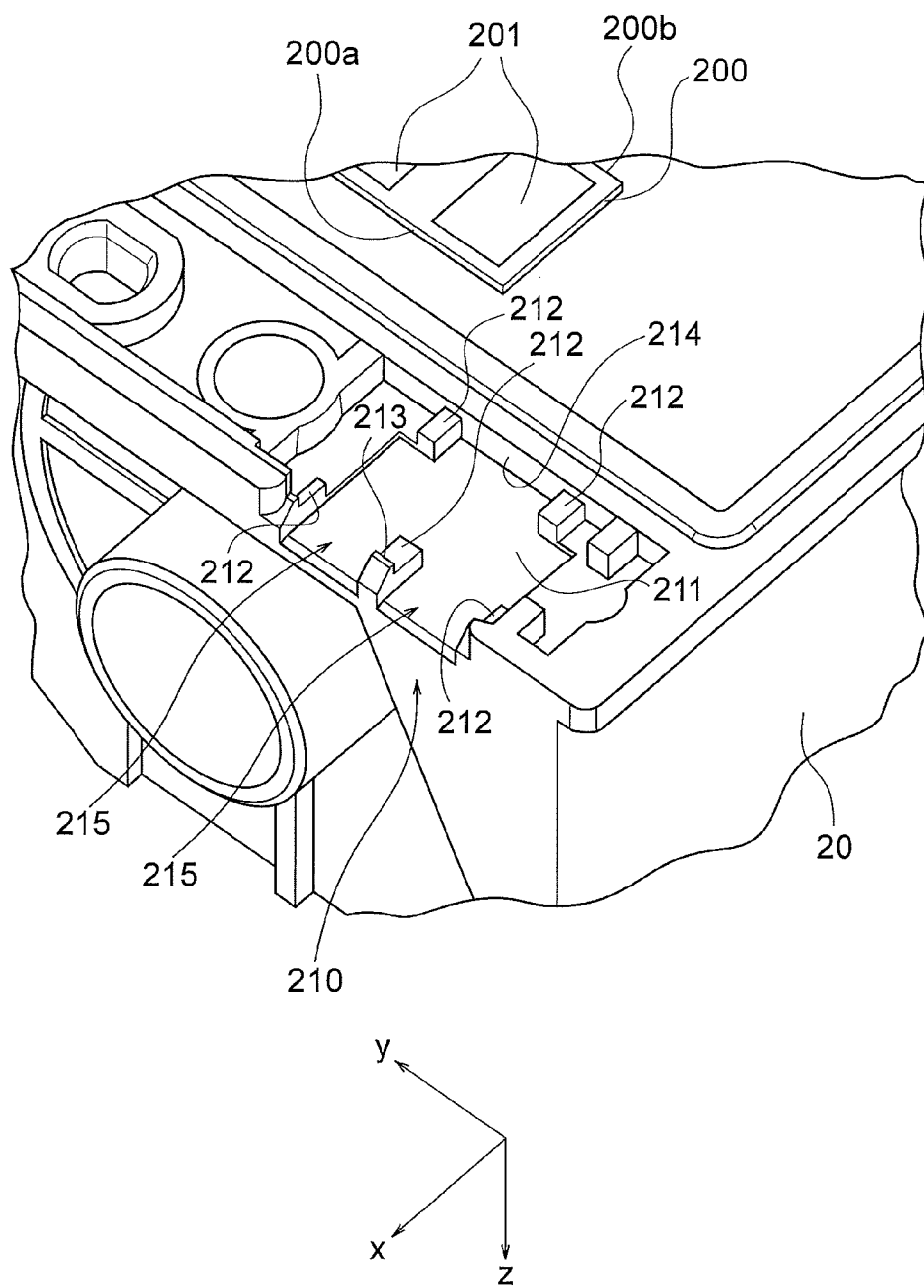


FIG. 6

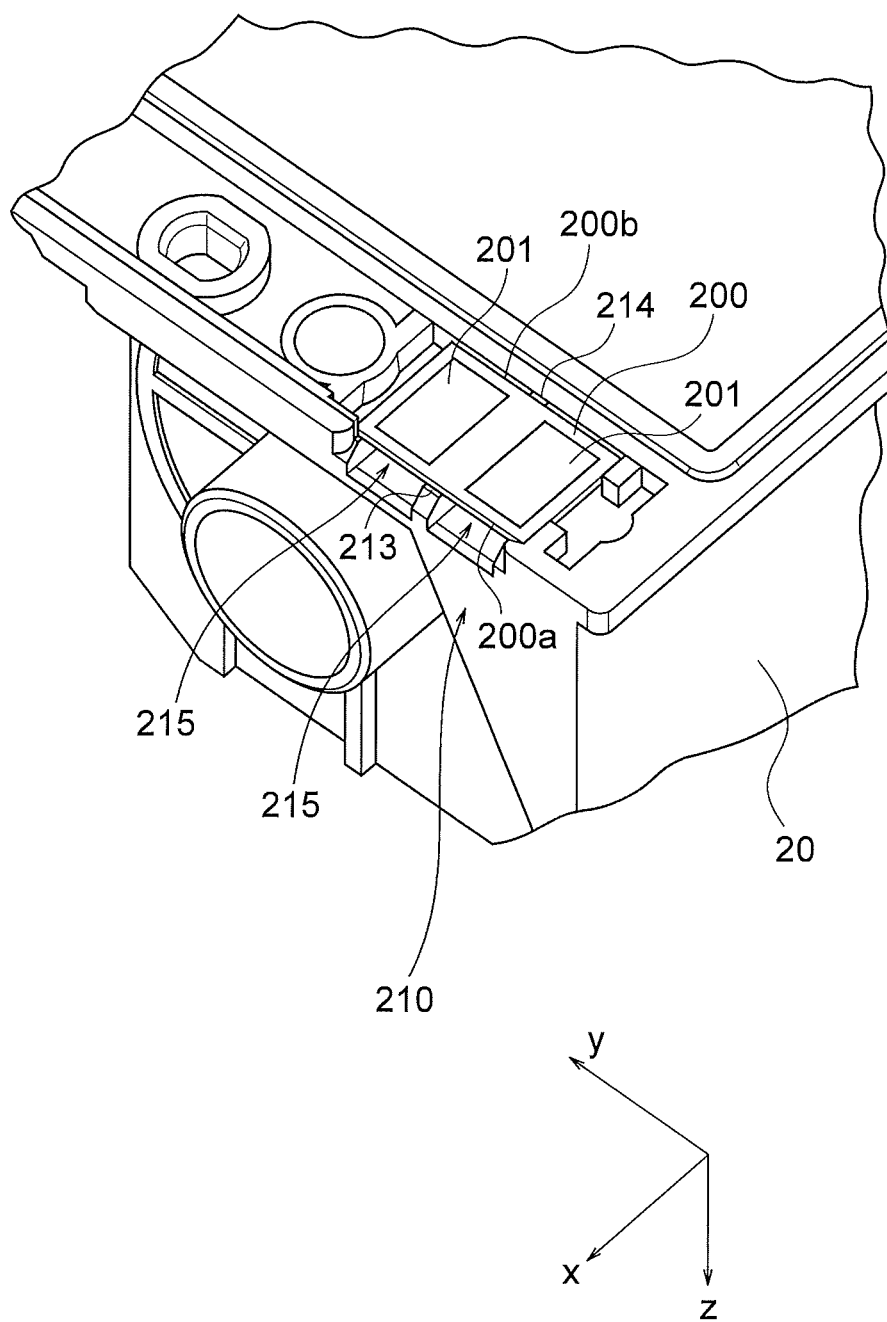


FIG. 7A

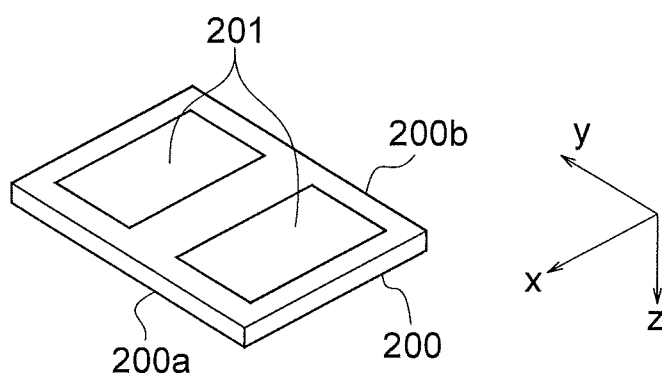


FIG. 7B

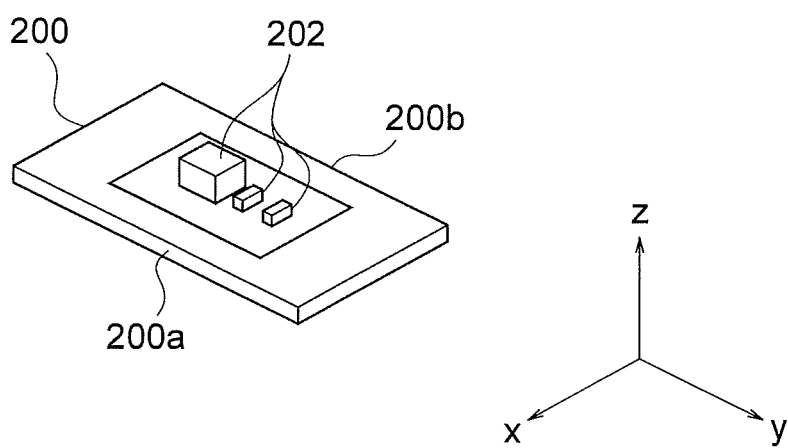


FIG. 8

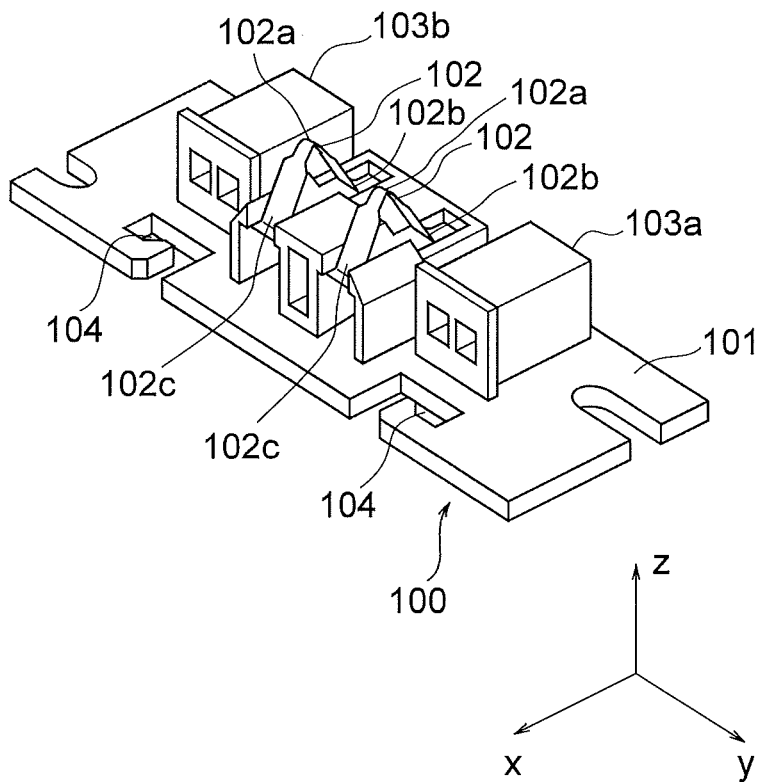




FIG. 9A

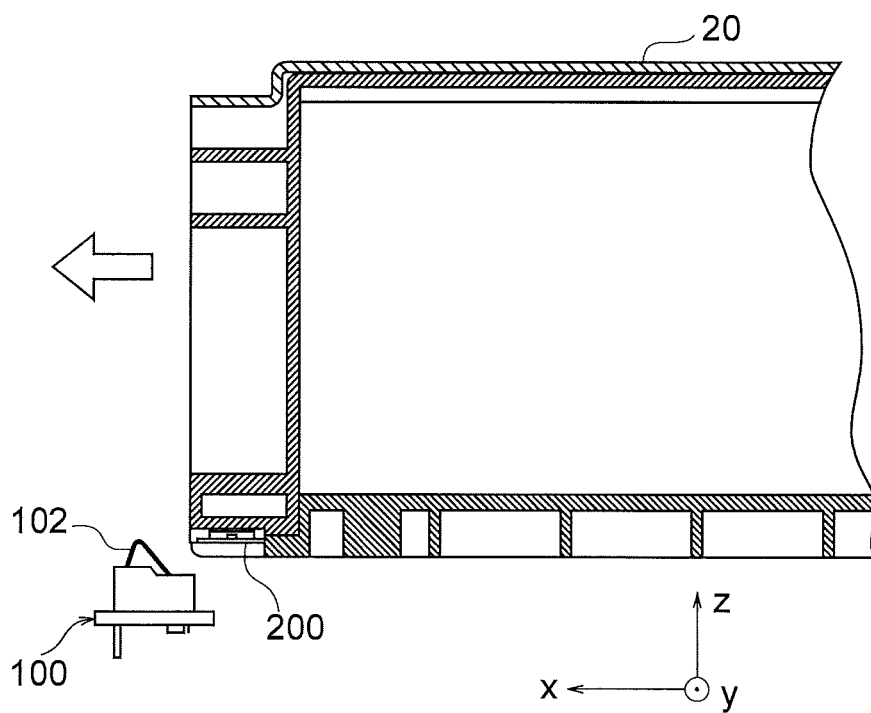


FIG. 9B

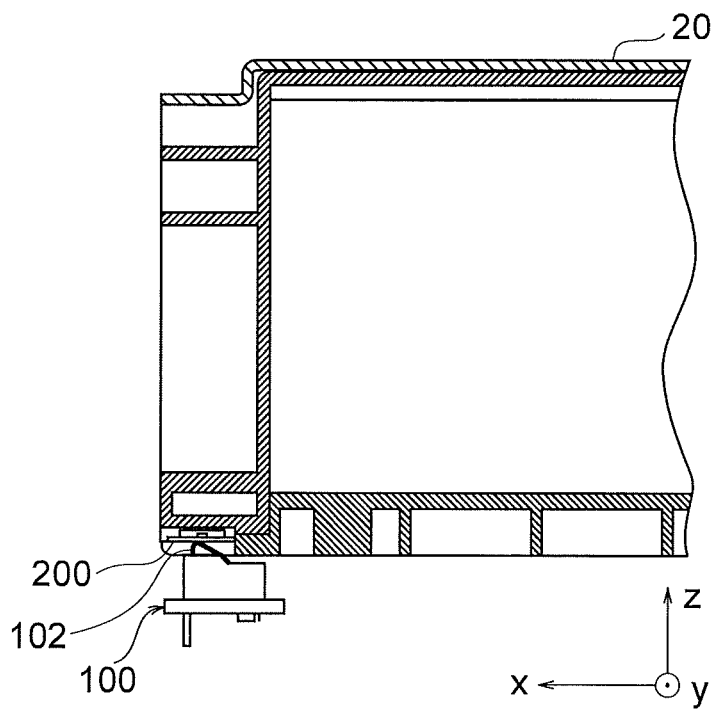


FIG. 10

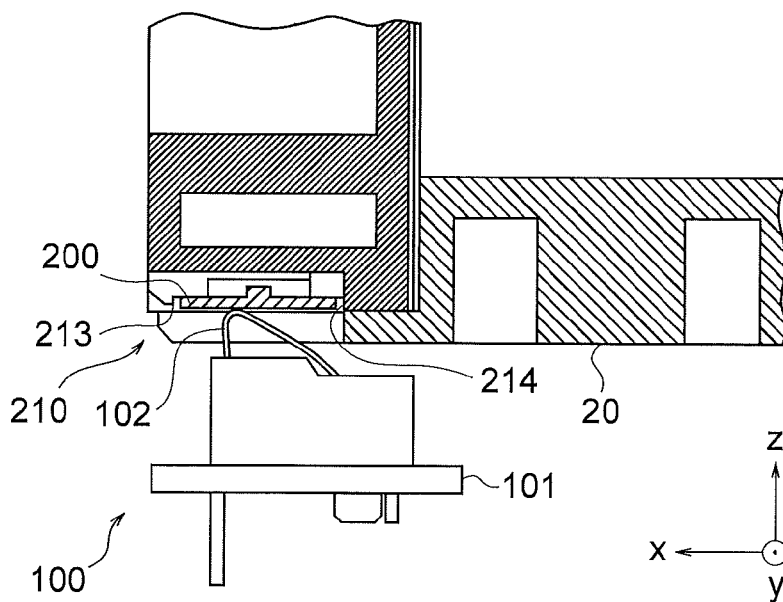


FIG. 11

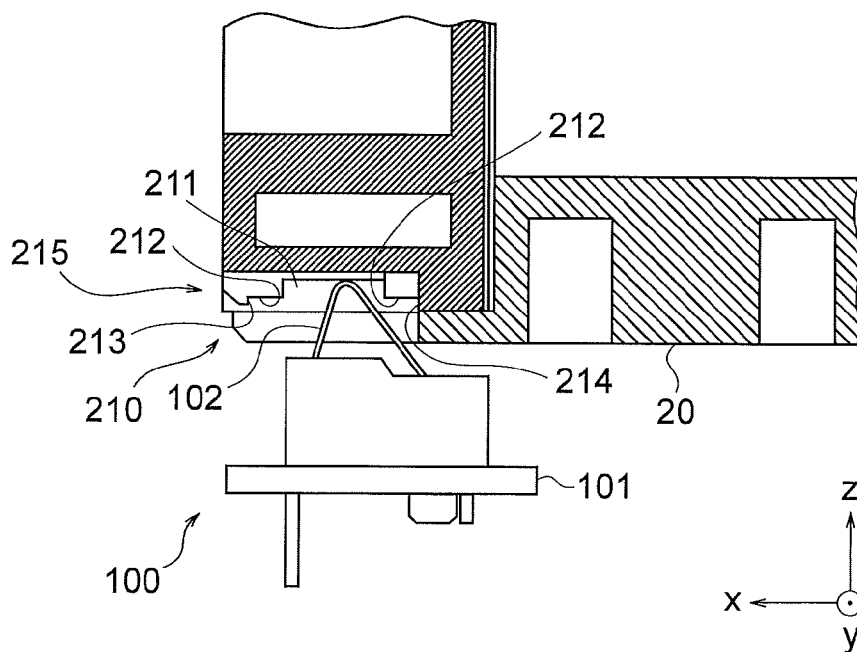


FIG. 12

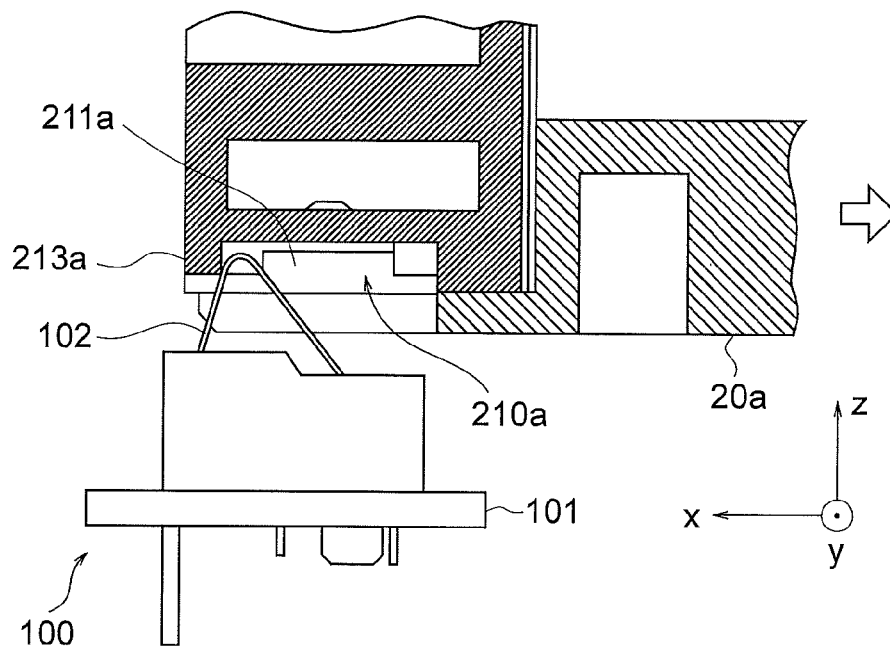


FIG. 13

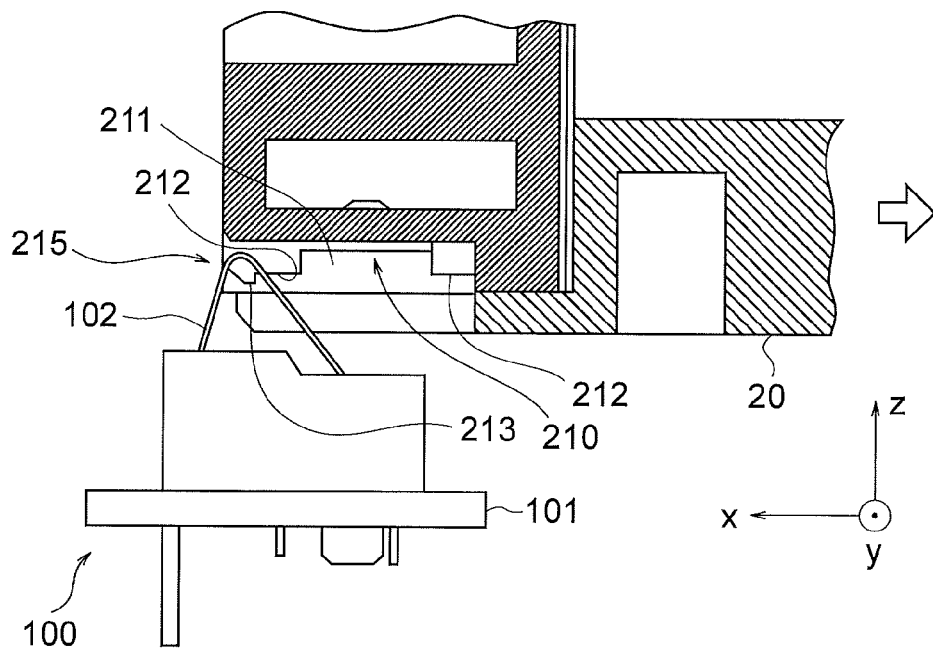


FIG. 14A

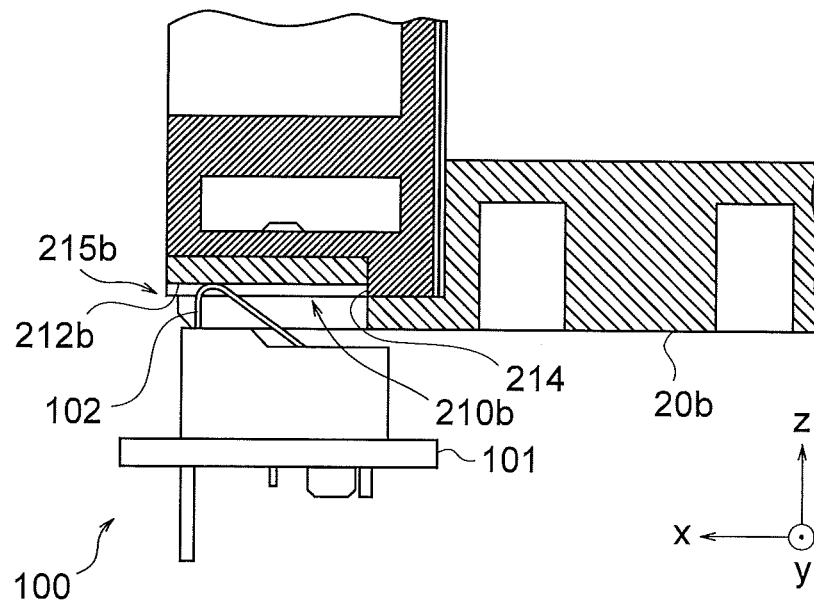


FIG. 14B

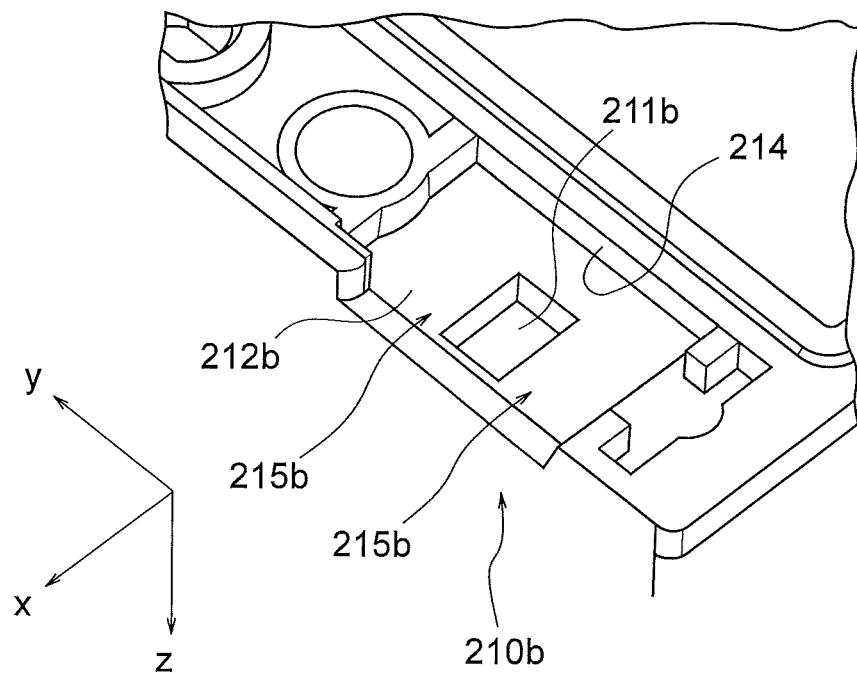


FIG. 15

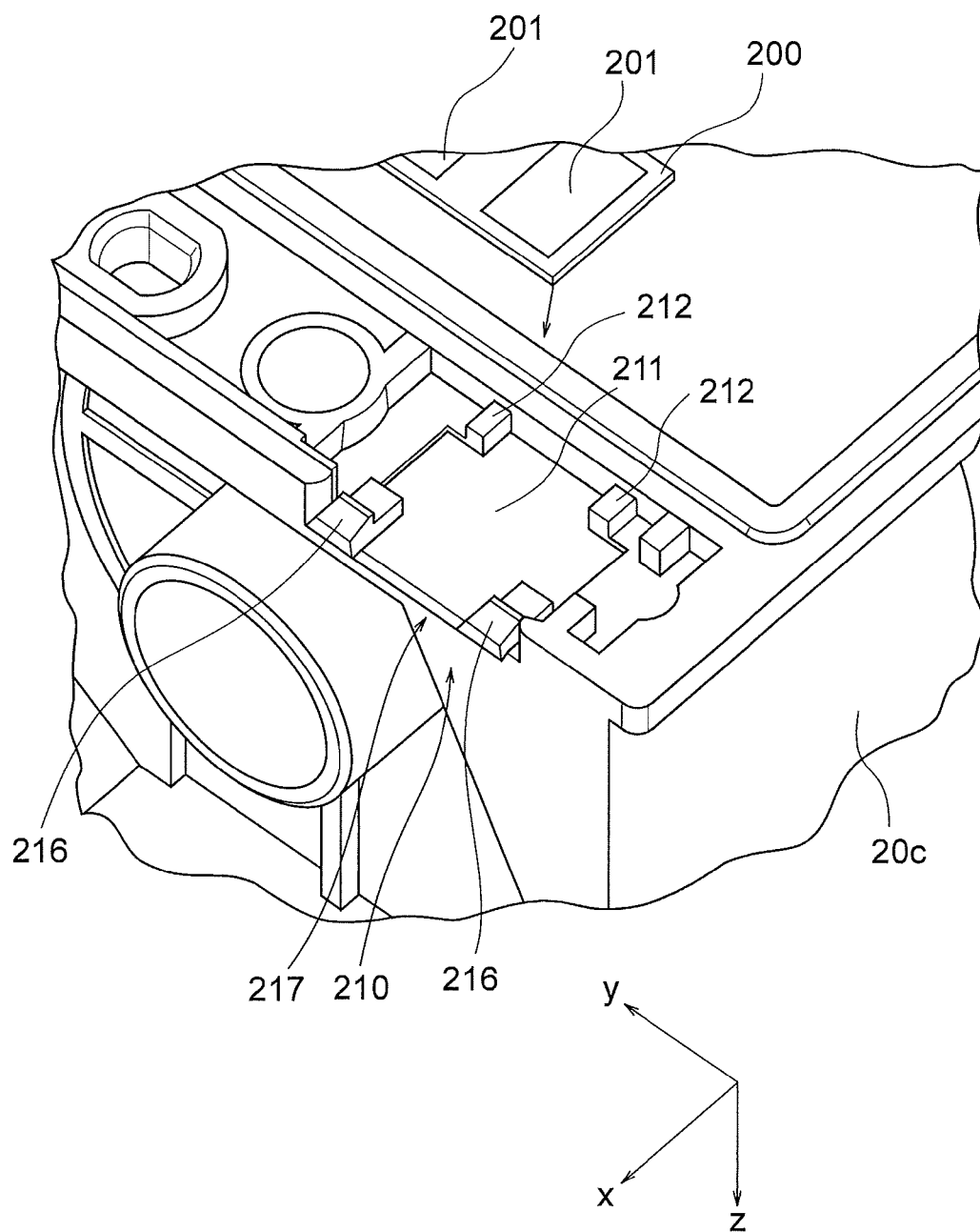


FIG. 16A

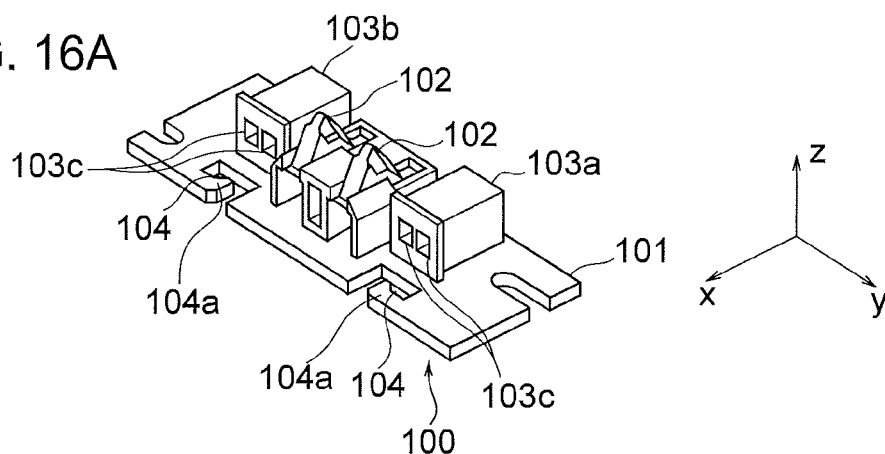


FIG. 16B

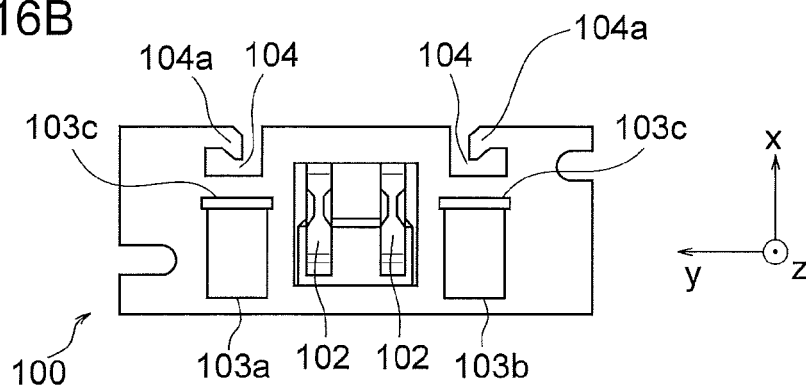


FIG. 16C

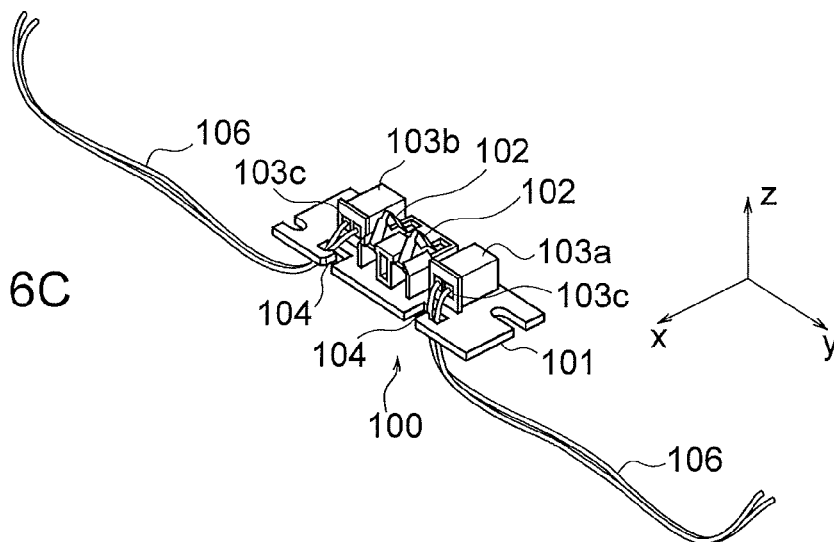


FIG. 17

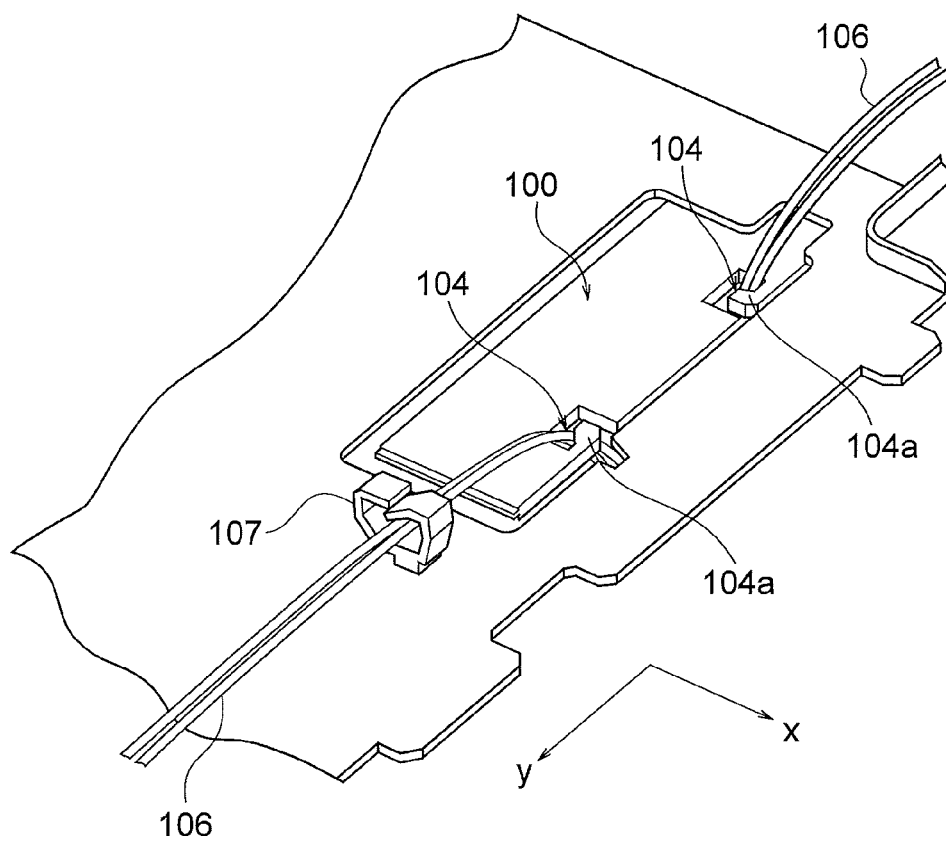


FIG. 18

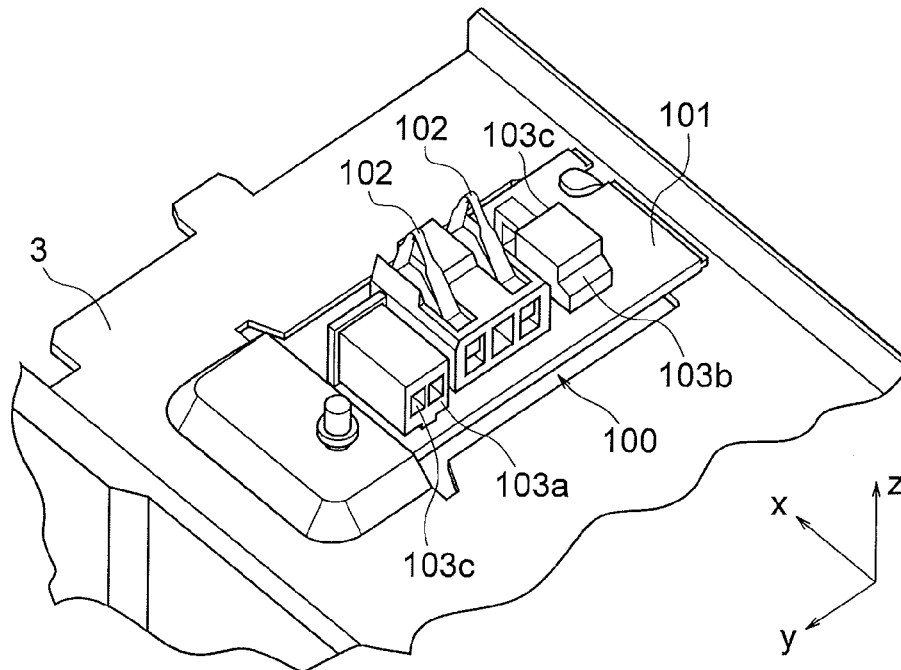


FIG. 19

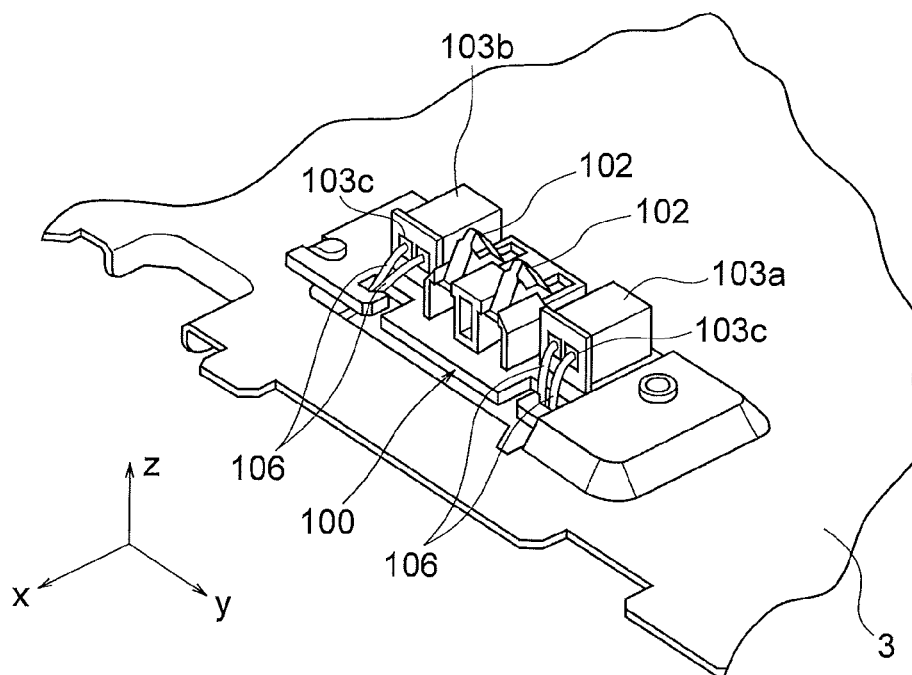
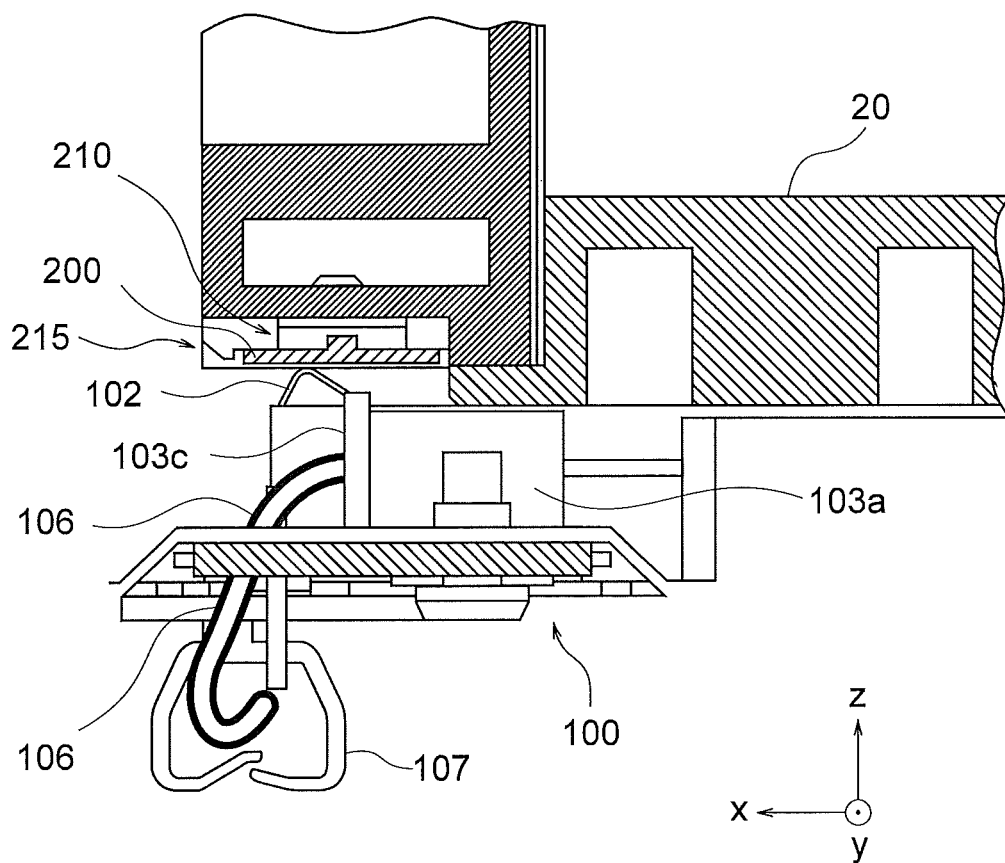




FIG. 20



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# IMAGE FORMING APPARATUS AND DETACHABLE UNIT FOR USE THEREWITH

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to image forming apparatuses each of which includes a detachable unit and detachable units that can be attached to and detached from image forming apparatuses.

### 2. Description of the Related Art

Conventionally, image forming apparatuses have a detachable unit that can be slid along a guide section of an apparatus main body when it is inserted into or withdrawn from the apparatus main body. One example of the detachable unit is a toner cartridge. In general, the detachable unit includes a holder for holding a circuit board (cartridge circuit board), and a terminal board having a contact terminal as a leaf spring is mounted on the apparatus main body. When the detachable unit is inserted into the guide section of the apparatus main body, an electrode terminal of the circuit board held in the holder of the detachable unit comes into contact with the contact terminal.

When the user inserts the detachable unit holding the circuit board in the holder along the guide section into the apparatus main body, the contact terminal in its initial state (non-pressed state) meets a part on the front end side of the holder of the detachable unit and is pushed down. When the insertion is completed, the contact terminal held in the holder is in the pressed state and is kept in contact with the electrode terminal of the circuit board by its elastic restoring force.

When the user draws out the detachable unit holding the circuit board in the holder from the apparatus main body by sliding it along the guide section, the detachable unit held in the holder moves while keeping the electrode terminal of the circuit board in contact with the contact terminal. When the detachable unit moves away from the contact terminal, the contact terminal returns from the pressed state to the initial state by its elastic restoring force. See Patent reference 1, Japanese patent application publication No. 2007-140266.

There is a possibility that a detachable unit which does not hold a circuit board in the holder (for example, a detachable unit before a circuit board is mounted or a detachable unit after a circuit board has been removed) is inserted into the apparatus main body along the guide section. When the user inserts the detachable unit not holding a circuit board in the holder into the apparatus main body along the guide section, the contact terminal in its initial state meets a part of the detachable unit (for example, a frame of the detachable unit) and is temporarily pushed down. However, when the insertion is completed, the contact terminal returns to its initial state by its elastic restoring force, and at least a part of the contact terminal enters into the holder (space where the circuit board would be present) of the detachable unit. If the user withdraws the detachable unit in that state by sliding it along the guide section, at least the part of the contact terminal which has been entering in the holder of the detachable unit would be caught by a part of the detachable unit (for example, a frame of the detachable unit), and the detachable unit would disturb smooth pulling-out of the detachable unit.

## SUMMARY OF THE INVENTION

An object of the present invention is to provide an image forming apparatus and a detachable unit that will allow the

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user to pull out the detachable unit smoothly when the user pulls out the detachable unit from the apparatus main body.

An image forming apparatus according to an aspect of the present invention includes: an apparatus main body including a guide section and a contact terminal as a spring; and a detachable unit including a holder for holding a circuit board having an electrode terminal which comes into contact with the contact terminal. A state of the detachable unit is changed to an attached state by inserting the detachable unit along the guide section in an insertion direction, and the state of the detachable unit is changed to a detached state by withdrawing the detachable unit along the guide section in a withdrawal direction opposite to the insertion direction. The holder includes a first positioning member for positioning a tip end of the circuit board in the insertion direction when the detachable unit holding the circuit board in the holder is slid along the guide section to be inserted in the insertion direction. The first positioning member includes a notch configured so that the contact terminal passes through the notch when the detachable unit not holding the circuit board in the holder in the attached state is slid in the withdrawal direction.

A detachable unit according to another aspect of the present invention, is configured to be inserted into and to be withdrawn from an image forming apparatus that includes a guide section and a contact terminal as a spring. A state of the detachable unit is changed to an attached state by inserting the detachable unit along the guide section in an insertion direction, and the state of the detachable unit is changed to a detached state by withdrawing the detachable unit along the guide section in a withdrawal direction opposite to the insertion direction. The detachable unit includes: a unit main body; and a holder provided on the unit main body, the holder being configured to hold a circuit board including an electrode terminal which comes into contact with the contact terminal. The holder includes a first positioning member for positioning a tip end of the circuit board in the insertion direction when the detachable unit holding the circuit board in the holder is slid along the guide section to be inserted in the insertion direction. The first positioning member includes a notch configured so that the contact terminal passes through the notch when the detachable unit not holding the circuit board in the holder in the attached state is slid in the withdrawal direction.

According to the present invention, the detachable unit is pulled out smoothly from the apparatus main body when the user pulls out the detachable unit from the apparatus main body.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a longitudinal sectional view schematically showing the structure of an image forming apparatus in a first embodiment of the present invention;

FIG. 2A is a perspective view schematically showing how a toner cartridge as a detachable unit in the first embodiment is inserted into a guide section disposed in an apparatus main body of the image forming apparatus;

FIG. 2B is a longitudinal sectional view schematically showing how the toner cartridge as the detachable unit in the first embodiment is inserted into the guide section disposed in the apparatus main body;

FIG. 3 is a perspective view showing a holder of the toner cartridge in the first embodiment;

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FIG. 4 is a perspective view showing the holder of the toner cartridge, a circuit board, and a securing member in the first embodiment;

FIG. 5 is an enlarged perspective view showing the holder of the toner cartridge in the first embodiment;

FIG. 6 is an enlarged perspective view showing the holder of the toner cartridge and the circuit board placed in the holder in the first embodiment;

FIG. 7A is a perspective view showing electrode terminals of the circuit board of the toner cartridge in the first embodiment;

FIG. 7B is a perspective view showing a semiconductor element of the circuit board of the toner cartridge in the first embodiment;

FIG. 8 is an enlarged perspective view showing a terminal board mounted on the apparatus main body of the image forming apparatus in the first embodiment;

FIG. 9A is a longitudinal sectional view showing the toner cartridge and the contact terminal provided on the side of the apparatus main body in the first embodiment (when the toner cartridge is being inserted);

FIG. 9B is another longitudinal sectional view showing the toner cartridge and the contact terminal provided on the side of the apparatus main body in the first embodiment (when the insertion of the toner cartridge is completed);

FIG. 10 is an enlarged sectional view showing the toner cartridge holding the circuit board in the holder and the contact terminal provided on the side of the apparatus main body (when the insertion of the toner cartridge is completed) in the first embodiment;

FIG. 11 is an enlarged sectional view showing the toner cartridge holding no circuit board in the holder and the contact terminal provided on the side of the apparatus main body (when the insertion of the toner cartridge is completed) in the first embodiment;

FIG. 12 is an enlarged sectional view showing a toner cartridge holding no circuit board in the holder and a contact terminal provided on the side of the apparatus main body in a comparative example;

FIG. 13 is an enlarged sectional view showing the toner cartridge holding no circuit board in the holder and the contact terminal provided on the side of the apparatus main body in the first embodiment;

FIG. 14A is an enlarged sectional view showing a toner cartridge holding no circuit board in the holder and a contact terminal on a side of the apparatus main body in a first modification of the first embodiment;

FIG. 14B is an enlarged perspective view of a holder of the toner cartridge in the first modification of the first embodiment;

FIG. 15 is an enlarged perspective view showing a toner cartridge holding no circuit board in the holder in a second modification of the first embodiment;

FIG. 16A is a perspective view schematically showing a terminal board of an image forming apparatus in a second embodiment of the present invention;

FIG. 16B is a plan view schematically showing the terminal board of the image forming apparatus in the second embodiment;

FIG. 16C is a perspective view schematically showing the terminal board and signal cables in the second embodiment;

FIG. 17 is an enlarged perspective view showing the signal cables and terminal board (back face side) mounted on the apparatus main body of the image forming apparatus in the second embodiment;

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FIG. 18 is an enlarged perspective view showing the terminal board (contact terminal side) mounted on the apparatus main body of the image forming apparatus in the second embodiment;

FIG. 19 is an enlarged perspective view showing the signal cables and terminal board (contact terminal side) mounted on the apparatus main body of the image forming apparatus in the second embodiment; and

FIG. 20 is a longitudinal sectional view showing the signal cable and the terminal board (contact terminal side) mounted on the apparatus main body of the image forming apparatus in the second embodiment.

#### DETAILED DESCRIPTION OF THE INVENTION

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications will become apparent to those skilled in the art from the detailed description.

Embodiments of the present invention will be described with reference to drawings. In the xyz orthogonal coordinate system shown in the drawings, the x-axis represents a direction of insertion (insertion direction) of the detachable unit (a long-side direction of a toner cartridge as the detachable unit in the embodiments). In the xyz orthogonal coordinate system, the y-axis represents a direction of width of the detachable unit (a short-side direction of the toner cartridge in the embodiments). In the xyz orthogonal coordinate system, the z-axis represents a direction of height of the detachable unit, orthogonal to both the x-axis and the y-axis (a direction of height of the image forming apparatus in the embodiments).

#### First Embodiment

FIG. 1 is a longitudinal sectional view schematically showing the structure of an image forming apparatus 1 in a first embodiment of the present invention. The image forming apparatus 1 is an electrophotographic color printer, for example. As shown in FIG. 1, an apparatus main body of the image forming apparatus 1 includes at least a housing 2 and a guide section 3 disposed in the housing 2. The image forming apparatus 1 further includes a power supply unit (a voltage supply unit) 4 which supplies electric power (a voltage) to the components of the image forming apparatus 1, a driving unit 5 (including a driving force generating unit such as a motor, and a driving force transfer unit such as a gear) which gives driving force to the components of the image forming apparatus 1, and a control section 6 which controls the operation of the image forming apparatus 1.

The image forming apparatus 1 includes image forming sections (image forming units) 10W, 10Y, 10M, 100, and 10K for forming developer (toner) images of various colors in an electrophotographic process, toner cartridges (developer cartridges) 20W, 20Y, 20M, 20C, and 20K for supplying toner of corresponding colors to the image forming sections 10W, 10Y, 10M, 100, and 10K, and a medium supply portion (paper feed unit) 30 for supplying recording medium P such as paper. The image forming apparatus 1 also includes a medium conveying portion (medium conveying section) 40 which conveys the recording medium P, an intermediate transfer unit (transfer belt unit) 50 including

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an intermediate transfer belt **51** for transferring color toner images formed by the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K**, a fixing unit **60** for fixing toner images transferred from the intermediate transfer belt **51** onto the recording medium **P**, and a medium discharge portion (paper discharge section) **70** for discharging the recording medium **P**, which has passed through the fixing unit **60**, onto a stacker (stacking portion) disposed outside the housing **2**.

FIG. **1** shows five image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** and five toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K**, but the number of image forming sections and the number of toner cartridges included in the image forming apparatus **1** may be four or less and may be six or more. FIG. **1** shows a color printer, but the present invention can be applied to a monochrome printer having a single image forming section. The present invention can be applied also to other types of electrical equipment including an apparatus main body and a detachable unit such as a toner cartridge which can be inserted into and withdrawn from the apparatus main body. For example, the present invention can be applied to other types of electric equipment such as a copier, a facsimile apparatus, and a multifunction peripheral (MFP).

As shown in FIG. **1**, the medium supply portion **30** includes a medium cassette (paper cassette) **31** mounted in the housing **2**, a paper feed roller (hopping roller) **32** for sending out the recording medium **P** one by one stacked in the medium cassette **31**, and a roller pair **33** for conveying the recording medium **P** sent out from the medium cassette **31**, toward the medium conveying portion **40**. The medium supply portion **30** may have a medium sensor **34** for detecting the presence or absence of the recording medium **P** in the medium cassette **31**. The structure of the medium supply portion **30** is not limited to the example shown in FIG. **1** and may have another structure.

The image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** form a white (W) toner image, a yellow (Y) toner image, a magenta (M) toner image, a cyan (C) toner image, and a black (K) toner image respectively by an electrophotographic process. The toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** as detachable units contain white toner, yellow toner, magenta toner, cyan toner, and black toner respectively, and supply them to the corresponding developing devices **14** of the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** respectively. The user can insert (slide) each of the toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** in the insertion direction (+x direction) along the guide section **3** disposed in the apparatus main body. By inserting them in the insertion direction, a state of each of the toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** is changed from a detached state to an attached state. Further, the user can pull out (slide) each of the toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** in a withdrawal direction (−x direction) opposite to the insertion direction along the guide section **3**. By withdrawing them in the withdrawal direction, a state of each of the toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** is changed from the attached state to the detached state. The toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** are examples of detachable units to which the present invention is applied. Toner used with the image forming section **10W** and the toner cartridge **20W** may be transparent toner instead of white toner.

The image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** have basically identical structures with each other except that the colors of toner are different from each other. The toner cartridges **20W**, **20Y**, **20M**, **20C**, and **20K** have basically identical structures with each other except that the

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colors of toner are different from each other. Each of the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** includes a light exposure unit (optical writing head) **11** which functions as an exposure device, a photosensitive drum **12** which is rotatably supported and functions as an image carrier, and a charging roller **13** for charging a surface of the photosensitive drum **12** uniformly. Each of the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** also includes a developing device **14** for supplying toner onto the surface of the photosensitive drum **12**, thereby forming the toner image corresponding to an electrostatic latent image which has been formed on the surface of the photosensitive drum **12** by exposure with the light exposure unit **11**, and a cleaning blade **15** for cleaning the surface of the photosensitive drum **12**. The light exposure unit **11** is an LED head including an LED array configured so that a plurality of LEDs (light emitting diodes) arranged in the direction of axis of the photosensitive drum **12**, for example. The light exposure unit **11** receives a driving signal based on the image data of each color and irradiates the surface of the photosensitive drum **12** with exposure light corresponding to the driving signal. The developing device **14** includes a toner storage member which forms a developer storage space for containing toner, a developing roller which supplies toner to the surface of the photosensitive drum **12**, and a supply roller which supplies toner stored in the toner storage member to the developing roller. The structure of the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** is not limited to the example described above and may have a different structure.

As shown in FIG. **1**, the medium conveying portion **40** includes roller pairs **41**, **42**, and **43** which convey the recording medium **P** supplied from the medium supply portion **30** and medium sensors **44**, **45**, and **46** which detect the recording medium **P**. The structure of the medium conveying portion **40** is not limited to the example shown in FIG. **1** and may have a different structure.

As shown in FIG. **1**, the intermediate transfer unit **50** includes rollers **52**, **53**, **54**, **55**, **56**, and **57** for movably supporting the intermediate transfer belt **51**, first transfer rollers **58W**, **58Y**, **58M**, **58C**, and **58K** which transfer respective toner images on the photosensitive drums **12** of the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** onto the intermediate transfer belt **51**, and a cleaning blade **59** which removes the toner remaining on a surface of the intermediate transfer belt **51**. The toner images transferred onto the intermediate transfer belt **51** are transferred onto the recording medium **P** by a second transfer roller **47**. The structure of the intermediate transfer unit **50** is not limited to the example shown in FIG. **1** and may have a different structure. The present invention can also be applied to an image forming apparatus which does not have the intermediate transfer unit **50** and transfers the toner images directly from the image forming sections **10W**, **10Y**, **10M**, **100**, and **10K** onto the recording medium **P**.

As shown in FIG. **1**, the fixing unit **60** includes a pair of rollers **61** and **62** which press each other. The roller **61** is a heat roller containing a heater in its inside, and the roller **62** is a pressure roller which is pressed against the roller **61**. When an unfixed toner image on the recording medium **P** passes between the rollers **61** and **62** of the fixing unit **60**, the toner image is fixed onto the recording medium **P** by heat and pressure. The structure of the fixing unit **60** is not limited to the example shown in FIG. **1** and may have a different structure.

As shown in FIG. **1**, the medium discharge portion **70** includes roller pairs **71**, **72**, **73**, and **74**, each of which

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includes a pair of rollers facing and pressing each other. Each of the roller pairs **71**, **72**, **73**, and **74** includes a roller which is rotated by the driving force to convey the recording medium P. The roller pairs **71**, **72**, **73**, and **74** discharge the recording medium P which has passed through the fixing unit **60** onto the stacker disposed outside the housing **2**. The medium discharge portion **70** may include a medium sensor **75** which detects the recording medium P. The structure of the medium discharge portion **70** is not limited to the example shown in FIG. **1** and may further include another roller pair, another sensor for detecting the passing of the recording medium P, and so on.

The image forming apparatus **1** shown in FIG. **1** may further include a paper turning mechanism which turns around the recording medium P which has passed through the fixing unit **60** and sends the turned recording medium P to the medium conveying portion **40**, in order to print images on both faces of the recording medium P.

FIGS. **2A** and **2B** are respectively a perspective view and a sectional view schematically showing how the toner cartridge **20** (any of **20W**, **20Y**, **20M**, **20C**, and **20K**) as a detachable unit in the first embodiment is slid along the guide section **3** and is inserted into the apparatus main body. As shown in FIGS. **2A** and **2B**, the image forming apparatus **1** includes five guide sections **3** arranged parallel to the y direction in the housing **2**, and the toner cartridges **20** (any of **20W**, **20Y**, **20M**, **20C**, and **20K**) are attached to each of the guide sections **3**. As shown in FIGS. **2A** and **2B**, each of the guide sections **3** includes a terminal board **100** as a base plate having a contact terminal **102**. As shown in FIG. **2B**, a holder **210** for holding a circuit board is provided on a frame as a unit main body of the toner cartridge **20**.

FIG. **3** is a perspective view showing the holder **210** of the toner cartridge **20** provided in an area **A1** in FIG. **2B**, and FIG. **4** is a perspective view showing the holder **210** of the toner cartridge **20** provided in the area **A1** in FIG. **2B**, the circuit board **200** placed in the holder **210**, and a securing member **230** (in a state before the circuit board **200** and the securing member **230** are attached) for securing the circuit board **200** in the holder to the frame. FIG. **5** is an enlarged perspective view showing the holder **210** of the toner cartridge **20** provided in the area **A1** in FIG. **2B**, and FIG. **6** is an enlarged perspective view showing the holder **210** of the toner cartridge **20** provided in the area **A1** of FIG. **2B** and the circuit board **200** disposed on the holder **210**. The holder **210** of the circuit board **200** in the toner cartridge **20** includes a recess (i.e., depressed part) **211** of which planar shape is nearly rectangular, a plurality of ribs (base parts or base members) **212** disposed in the recess **211**, a first positioning member (first positioning part) **213**, and a second positioning member (second positioning part) **214**. The top faces of the plurality of ribs **212** are on the same level in height. One face (which is opposed to a face on which the electrode terminal **201** is provided) of the circuit board **200** is supported by the top faces of the plurality of ribs **212**. The first positioning member **213** comes into contact with a side **200a** (front side) as a tip end of the circuit board **200** and positions the circuit board **200** in the insertion direction (+x direction). The second positioning member **214** comes into contact with a side **200b**, which is different from the side **200a**, of the circuit board **200** and positions the circuit board **200** in the withdrawal direction (-x direction).

FIG. **7A** is a perspective view showing a side of the electrode terminal **201** of the circuit board **200** held in the holder **210** of the toner cartridge **20** in the image forming apparatus **1**. FIG. **7B** is a perspective view showing a side of the semiconductor element **202** of the circuit board **200** of

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the toner cartridge **20** in the image forming apparatus **1**. It is preferable that the electrode terminal **201** of the circuit board **200** be a tabular electrode parallel to the insertion direction (+x direction). A substrate part of the circuit board **200** has a size of about 15 mm in length, about 10 mm in width, and about 1 mm in thickness, for example. The semiconductor element **202** includes a memory element and stores information about the toner cartridge such as identification information for identifying the toner cartridge. The information which is stored by the memory element can include a variety of information such as information indicating the amount of the toner consumed, information indicating whether the toner cartridge is a new one or not, and information indicating the color of the toner.

The apparatus main body of the image forming apparatus **1** includes the guide section **3** and the terminal board **100** having two contact terminals **102** as springs having a spring characteristic. The toner cartridge **20** includes the holder **210** for holding the circuit board **200** which has two electrode terminals **201** to come into contact with the contact terminals **102**. To change the state of the toner cartridge **20** from the detached state to the attached state, the user inserts the toner cartridge **20** into the apparatus main body by sliding it along the guide section **3** in the insertion direction (+x direction). To change the state of the toner cartridge **20** from the attached state to the detached state, the user withdraws the toner cartridge **20** from the apparatus main body by sliding it along the guide section **3** in the withdrawal direction (-x direction). The holder **210** includes the first positioning member **213** which positions the front side **200a** as the tip end of the circuit board **200** held in the holder in the insertion direction (+x direction) when the toner cartridge **20** holding the circuit board **200** in the holder **210** is slid along the guide section **3** to be inserted in the insertion direction. The first positioning member **213** includes notches as cut parts (slit parts) **215** configured so that two contact terminals **102** pass through the notches **215** when the toner cartridge **20** not holding the circuit board **200** in the holder **210** (in the attached state) is slid in the withdrawal direction (-x direction). The number of the contact terminals **102** may be one and may be three or more. The number of the notches **215** may be one and may be three or more. The notch **215** should preferably have such a shape that the holder **210** does not touch the contact terminal **102** while the toner cartridge **20** is being inserted into the apparatus main body and is being withdrawn from the apparatus main body. If the bottom face of the notch **215** in the holder **210** is smooth (free of acute parts) and if the bottom face is lower than the ribs **212**, even when the bottom face of the notch **215** of the holder **210** touches the contact terminal **102** while the toner cartridge **20** is being inserted into and being withdrawn from the apparatus main body, damage to the contact terminals **102** can be prevented.

The holder **210** includes the second positioning member **214** which positions the side **200b** as a rear end of the circuit board **200** held in the holder **210** in the insertion direction (+x direction) and the recess **211** formed between the first positioning member **213** and the second positioning member **214**. The first positioning member **213** and the second positioning member **214** are formed on a level higher than the top faces of the ribs **212**. The recess **211** is formed on a level lower than the top faces of the ribs **212**.

FIG. **8** is an enlarged perspective view showing the terminal board **100** mounted on the apparatus main body of the image forming apparatus **1** in the first embodiment. The terminal board **100** includes board part **101** (printed board) having a first face on which the contact terminal **102** as a

spring is disposed and a second face opposite to the first face. In other words, the terminal board 100 supports the two contact terminals 102 as springs on the first face (board part 101). The terminal board 100 also includes two connectors 103a and 103b for electrically connecting the two contact terminals 102 to signal cables respectively. Each of the contact terminals 102 is an L-shaped leaf spring member which functions as a spring. The contact terminals 102 and the connectors 103a and 103b are electrically connected through printed wiring printed on a surface of the terminal board 100. Accordingly, the contact terminals 102 and the signal cables 106 are electrically connected via the connectors 103a and 103b. An apex part 102a of the contact terminal 102 bent into the L-shape is a contact part which comes into contact with the electrode terminal 201 of the circuit board 200 held in the holder 210. The apex part 102a is formed by bending a plate member into L-shape, for example. In the attached state where the toner cartridge 20 holding the circuit board 200 in the holder 210 is inserted into the apparatus main body, the contact terminals 102 are in contact with the electrode terminals 201. It is preferable that the apex part 102a of the contact terminal 102 be plated with gold. When a load is applied to the apex part 102a of the contact terminal 102 from above, the apex part 102a of the contact terminal 102 is compressed and pushed down toward the board part 101. When the load on the apex part 102a of the contact terminal 102 is released, the apex part 102a of the contact terminal 102 returns to its initial state by the elastic restoring force of the contact terminal 102. An end part 102b of the contact terminal 102 on a rear end side opposite to a tip end side in the insertion direction (+x direction) is a fixed end which is fixed to the apparatus main body (more specifically, the board part 101, for example). Another end part 102c of the contact terminal 102 on the tip end side opposite to the rear side in the insertion direction (+x direction) is a free end which is not fixed to the board part 101. In other words, the fixed end is formed on the rear end side of the contact terminal 102 in the insertion direction, and the free end is formed on the tip end side of the contact terminal 102 in the insertion direction. Accordingly, if a load is applied to the apex part 102a (contact part) of the contact terminal 102 from above, the fixed end (the end part 102b) of the contact terminal 102 functions as a fulcrum, and a free end side (the end part 102c) is pushed down toward the board part 101. The structure of the terminal board 100 is not limited to the example shown in FIG. 8, and a variety of modifications are possible. The terminal board 100 includes L-shaped notches 104 as a part of a cable guide, which will be described in the description of a second embodiment.

FIG. 9A is a longitudinal sectional view showing the toner cartridge 20 and the contact terminal 102 provided on the side of the apparatus main body in the first embodiment (when the toner cartridge 20 is being inserted), and FIG. 9B is a longitudinal sectional view showing the toner cartridge 20 and the contact terminal 102 provided on the side of the apparatus main body in the first embodiment (when the insertion of the toner cartridge 20 is completed). When the toner cartridge 20 holding the circuit board 200 in the holder 210 is inserted into the apparatus main body along the guide section 3, the contact terminal 102 changes its state from the initial state (FIG. 9A) in which no load is applied to the contact terminal 102, to a contact state (FIG. 9B) in which it meets the circuit board 200 held in the holder 210 and is pushed down by the circuit board 200. The contact terminal 102 is in contact with the electrode terminal 201 when the toner cartridge 20 holding the circuit board 200 in the holder

210 is in the attached state (contact state). When the toner cartridge 20 holding the circuit board in the holder 210 is withdrawn from the apparatus main body along the guide section 3, the contact terminal 102 returns from the contact state (FIG. 9B) to the initial state (FIG. 9A).

FIG. 10 is an enlarged sectional view showing the toner cartridge 20 (holding the circuit board 200) and the contact terminal 102 provided on the side of the apparatus main body (when the insertion of the toner cartridge 20 is completed) in the first embodiment. As shown in FIG. 10, when the toner cartridge 20 holding the circuit board 200 in the holder 210 is inserted into the apparatus main body along the guide section 3, the shape of the contact terminal 102 changes from the initial state (FIG. 9A), in which no load is applied, to the contact state, in which it comes into contact with or meets the circuit board 200 held in the holder 210 and is pushed down thereby.

FIG. 11 is an enlarged sectional view showing the toner cartridge 20 (not holding the circuit board 200 in the holder 210, i.e., holding no circuit board in the holder 210) and the contact terminal 102 provided on the side of the apparatus main body (when the insertion of the toner cartridge 20 is completed) in the first embodiment. As shown in FIG. 11, the holder 210 includes the second positioning member 214 which positions a rear end of the circuit board 200 held in the holder 210 in the insertion direction (+x direction) and the recess 211 between the first positioning member 213 and the second positioning member 214, and when the toner cartridge 20 not holding the circuit board 200 in the holder 210 is in the attached state, at least a part (more specifically, the apex part 102a, for example) of the contact terminal 102 is located in the recess 211.

FIG. 12 is an enlarged sectional view showing a comparative example, which is a toner cartridge 20a as the detachable unit not holding the circuit board 200 in a holder 210a, and the contact terminal 102 provided on the side of the apparatus main body. As shown in FIG. 12, a first positioning member 213a does not have a notch (a part corresponding to the notch 215 in FIG. 5). FIG. 12 shows a state in which the toner cartridge 20a not holding the circuit board 200 in the holder 210a is pulled out of (withdrawn from) the apparatus main body along the guide section of the image forming apparatus. When the user slides the toner cartridge 20a along the guide section into the apparatus main body, the contact terminal 102 in its initial state meets the first positioning member 213a (a positioning part of the circuit board) on a tip end side of the holder 210a of the toner cartridge 20a and is temporarily pushed down thereby. When the insertion is completed, the contact terminal 102 returns to the initial state by its elastic restoring force and enters into the recess 211a (space where the circuit board 200 should be present) of the holder 210a of the toner cartridge 20a. As shown in FIG. 12, if the user pulls out the toner cartridge 20a in that state by sliding it along the guide section, when the contact terminal 102 comes out of the recess 211a of the holder 210a of the toner cartridge 20a, the contact terminal 102 can be caught by the positioning member 213a on the tip end side of the holder 210a of the toner cartridge 20a and can be damaged thereby.

FIG. 13 is an enlarged sectional view showing the toner cartridge 20 not holding the circuit board 200 in the holder 210 (i.e., holding no circuit board in the holder) and the contact terminal 102 provided on the side of the apparatus main body of the image forming apparatus 1 in the first embodiment. As shown in FIG. 13, the first positioning member 213 includes a notch 215 (corresponding to the notch 215 in FIG. 5). FIG. 13 shows a state in which the

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toner cartridge **20** not holding the circuit board **200** in the holder is pulled out of the apparatus main body along the guide section **3**. When the user slides the toner cartridge **20** along the guide section **3** into the apparatus main body, the contact terminal **102** in its initial state passes through the notch **215** of the holder **210** of the toner cartridge **20**. When the insertion is completed, the contact terminal **102** is still in its initial state and is located in the recess **211** (space where the circuit board **200** should be present) in the holder **210** of the toner cartridge **20** (FIG. **11**). In that state, the locking member of the toner cartridge **20** is engaged with a member in the apparatus main body and is placed in a predetermined position. As shown in FIG. **13**, when the user pulls out the toner cartridge **20** in the attached state by sliding it along the guide section **3**, the contact terminal **102** being located in the recess **211** of the holder **210** of the toner cartridge **20** passes through the notch **215** without being caught by the first positioning member **213** on the tip end side of the holder **210** of the toner cartridge **20**. Therefore, the contact terminal **102** in the example shown in FIG. **13** is not be damaged.

As described above, in the image forming apparatus **1** and the toner cartridge **20** according to the first embodiment, the notch **215** is disposed in the frame (unit main body) of the toner cartridge **20** so that the contact terminal **102** does not meet or touch the frame, the image forming apparatus **1** and the toner cartridge **20** allow the user to pull out the toner cartridge **20** smoothly even when the user pulls out the toner cartridge **20** not holding the circuit board **200** in the holder **210** from the apparatus main body.

## First Modification of First Embodiment

FIG. **14A** is an enlarged sectional view showing a toner cartridge **20b** holding no circuit board in a holder **210b** and a contact terminal **102** of an apparatus main body in an image forming apparatus according to a first modification of the first embodiment. FIG. **14B** is an enlarged perspective view of the holder **210b** in FIG. **14A**. In FIGS. **14A** and **14B**, components identical to or corresponding to the components shown in FIG. **13** are denoted by the same reference numerals as used in FIG. **13**. In the example shown in FIGS. **14A** and **14B**, a shape of the holder **210b** differs from that shown in FIG. **13**. In the example shown in FIGS. **14A** and **14B**, a face **212b** corresponding to the top face of the rib **212** in FIG. **5** is formed across an area excluding a recess **211b** of the holder **210b**, the bottom (top face) of a part (notch or cut part) **215b** corresponding to the notch **215** is on the same level as the face **212b**. In other words, the face **212b** and the part **215b** form a flat face. The part **215b** corresponding to the notch **215** is formed on an end part of the holder **210b** in the x direction. In this example, the face **212b** of the holder **210b** touches the contact terminal **102**, but since no member has such a shape that the contact terminal **102** is caught, when the toner cartridge **20b** is pulled out in the withdrawal direction, damage to the contact terminal **102** can be prevented. Further, the contact terminal **102** does not enter the recess **211b**. Furthermore, the face **212b** in the holder **210b** may be configured not to touch the contact terminal **102**. Otherwise, the example shown in FIGS. **14A** and **14B** is the same as that shown in FIG. **13**. As described above, in the image forming apparatus and the toner cartridge **20b** according to the first modification of the first embodiment, the image forming apparatus and the toner cartridge **20b** allow the user to pull out the toner cartridge **20b** smoothly even when the user pulls out the toner

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cartridge **20b** not holding the circuit board **200** in the holder **210b** from the apparatus main body.

## Second Modification of First Embodiment

FIG. **15** is an enlarged perspective view showing a part of a toner cartridge **20c** not holding a circuit board in the holder in an image forming apparatus according to a second modification of the first embodiment. In FIG. **15**, components identical to or corresponding to the components shown in FIG. **5** are denoted by the same reference numerals as used in FIG. **5**. In the example shown in FIG. **15**, shapes of the first positioning parts **216** differ from those shown in FIG. **5**, and a shape of the notch **217** differs from that shown in FIG. **5**. In the example shown in FIG. **15**, the first positioning parts **216** are formed near both ends of the holder **210** in the y direction instead of in the center of the holder **210** in the y direction. The notch **217**, through which the contact terminal **102** passes, is formed around the center of the holder **210** in the y direction. Since no member has such a shape that the contact terminal **102** is caught, when the toner cartridge **20c** is pulled out in the withdrawal direction, damage to the contact terminal **102** can be prevented. Otherwise, the example shown in FIG. **15** is the same as the example shown in FIG. **5**. As described above, in the image forming apparatus and the toner cartridge **20c** according to the second modification of the first embodiment, the image forming apparatus and the toner cartridge **20c** allow the user to pull out the toner cartridge **20c** smoothly even when the user pulls out the toner cartridge **20c** not holding the circuit board **200** in the holder **210** from the apparatus main body.

## Second Embodiment

In the first embodiment, the connectors **103a** and **103b** electrically connected to the contact terminals **102** are disposed near the contact terminals **102** of the terminal board **100** mounted on the apparatus main body. If the signal cables **106** that connect the connectors **103a** and **103b** with the control section **6** of the image forming apparatus **1** or connect the connectors **103a** and **103b** with the connectors of the adjacent terminal board **100** (in series) are disposed on a face of the board part (printed board) **101** of the terminal board **100** on which the contact terminals **102** is disposed, the signal cables **106** could be damaged when they touch the toner cartridge **20** which is sliding.

In an image forming apparatus according to a second embodiment, the signal cables **106** are routed from the connectors **103a** and **103b** of the terminal board **100** through the L-shaped notches **104** toward a back face (i.e., the second face) and fixed on the back face. Although the route of the signal cable **106** is not limited in the first embodiment, the signal cable **106** in the second embodiment is routed to and fixed on the back face of the terminal board **100**. Otherwise, the second embodiment is the same as the first embodiment (FIGS. **1** to **11**, FIGS. **13** to **15**) or the comparative example (FIG. **12**).

FIGS. **16A** to **16C** are views schematically showing the terminal board **100** of the image forming apparatus according to the second embodiment of the present invention. FIG. **16A** is a perspective view of the terminal board **100**. FIG. **16B** is a plan view of the terminal board **100**. FIG. **16C** is a perspective view showing the terminal board **100** and the signal cables **106**. FIG. **17** is an enlarged perspective view showing the signal cables **106** and the terminal board **100** mounted on the apparatus main body of the image forming apparatus in the second embodiment, viewed from the back

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side of the terminal board 100. FIG. 18 is an enlarged perspective view showing the terminal board 100 mounted on the apparatus main body of the image forming apparatus in the second embodiment. FIG. 19 is an enlarged perspective view showing the signal cables 106 and the terminal board 100 mounted on the apparatus main body of the image forming apparatus in the second embodiment. FIG. 20 is a longitudinal sectional view showing the signal cable 106 and the terminal board 100 mounted on the apparatus main body of the image forming apparatus in the second embodiment.

As shown in FIGS. 16A to 16C and FIG. 20, the connectors 103a and 103b have a slot 103c into which the signal cable 106 is inserted. The signal cable 106 inserted into the slot 103c extends from the first face on which the connectors 103a and 103b are disposed to the second face opposite to the first face along the cable guide (more specifically, an L-shaped notch 104, for example). As shown in FIGS. 16A and 16B, the terminal board 100 (more specifically, the L-shaped notch 104, for example) includes a hook 104a as a bent part which prevents the signal cable 106 from coming out of the L-shaped notch 104. This structure prevents the signal cable 106 put into the deepest part of the L-shaped notch 104 from coming out. As shown in FIG. 17, a clamp 107 is disposed on the back side of the plate supporting the terminal board 100 (or the back side of the guide section 3), and the clamp 107 holds the signal cable 106. The signal cables 106 are connected to the contact terminals 102 by the connectors 103a and 103b. It is preferable that the connectors 103a and 103b be an angle connector having two connection terminals disposed to form a right angle to each other and to electrically connect the contact terminals 102 and the signal cables 106 by connecting a vertically downward cable and a horizontal cable thereof. It is preferable that the angle connector include a slot configured to be inserted by the signal cable 106 and to face in the insertion direction. In the example shown in FIG. 18, the slots 103c of the connectors 103a and 103b face in different directions. It is, however, preferred that the connectors 103a and 103b are disposed in such a manner that all the slots 103c face the tip end side of the toner cartridge 20 in the insertion direction (+x direction), as shown in FIG. 19 and FIG. 20. This structure makes it possible to avoid contact between the signal cable 106 and the toner cartridge 20 when the toner cartridge 20 is inserted into the apparatus main body. The structure of the cable guide is not limited to L-shape such as the L-shaped notch 104. The terminal board 100 may include a through hole as a part of the cable guide to pass the signal cable 106.

To prevent a signal cable from touching a sliding member such as a toner cartridge, it is preferable that the signal cable be covered with a cover member or that a connector connected to a contact terminal be disposed on a face opposite to a face on which the contact terminal is disposed, for example. In the image forming apparatus in the second embodiment, however, the connectors 103a and 103b and the contact terminal 102 are disposed on the same face of the terminal board 100, the signal cables 106 connected to the connectors 103a and 103b are routed through the L-shaped notches 104 toward the back face of the terminal board 100, and the signal cables 106 are fixed on the back face of the terminal board 100. Accordingly, in the second embodiment, damage to the signal cable 106 can be prevented by the simple structure.

In the second embodiment, the most part of the signal cable 106 is placed on the opposite side to the toner cartridge 20 across the terminal board 100, and there is little possibility that the signal cable 106 touches the toner cartridge 20.

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Even when adjacent terminal boards 100 are connected in series by the signal cable 106, the signal cable 106 can be routed on the face (back face of the guide section 3) opposite to the face on which the toner cartridge 20 is disposed, and flexibility of cabling increases.

The L-shaped notch 104 of the terminal board 100 which functions as the cable guide is formed near the end part of the terminal board 100. Alternatively, a through hole which functions as the cable guide may be formed in a position near the center of the terminal board 100. If the through hole is used as the cable guide, it is necessary to put the signal cable 106 into the through hole from its end. If the L-shaped notch 104 is used as the cable guide, since the signal cable 106 can be put into the L-shaped notch 104 at a given middle point, using the L-shaped notch 104 as the cable guide facilitates the cabling.

#### Modification

The toner cartridge as the developer cartridge containing a developer has been described above as an example of a detachable unit to which the present invention is applied. The present invention can also be applied to an image forming unit including a photosensitive drum as an image carrier on which the electrostatic latent image is formed, a transfer belt unit including an intermediate transfer belt onto which the developer image formed on the image carrier is transferred, a fixing unit including fixing rollers which fixes the developer image onto the recording medium, and other detachable units configured so that they are inserted into and pulled out of the apparatus main body by being slid.

What is claimed is:

1. An image forming apparatus comprising:

an apparatus main body including a guide section and a contact terminal as a spring; and

a detachable unit including a holder for holding a circuit board having an electrode terminal which comes into contact with the contact terminal, a state of the detachable unit being changed to an attached state by inserting the detachable unit along the guide section in an insertion direction, the state of the detachable unit being changed to a detached state by withdrawing the detachable unit along the guide section in a withdrawal direction opposite to the insertion direction, wherein:

the holder includes a first positioning member for positioning a tip end of the circuit board in the insertion direction when the detachable unit holding the circuit board in the holder is slid along the guide section to be inserted in the insertion direction; and

the first positioning member forms two slit parts, through which the contact terminal passes when the detachable unit not holding the circuit board in the holder in the attached state is slid in the withdrawal direction.

2. The image forming apparatus of claim 1, wherein:

the holder includes a second positioning member which positions a rear end of the circuit board in the insertion direction, the rear end being opposite to the tip end; and a recess formed between the first positioning member and the second positioning member; and

at least a part of the contact terminal is located in the recess when the detachable unit not holding the circuit board in the holder is in the attached state.

3. The image forming apparatus of claim 1, wherein the contact terminal is in contact with the electrode terminal when the detachable unit holding the circuit board in the holder is in the attached state.

4. The image forming apparatus of claim 1, wherein the electrode terminal is a tabular electrode parallel to the insertion direction.



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5. The image forming apparatus of claim 1, wherein:  
the contact terminal changes from an initial state, in which  
no load is applied to the contact terminal, to a contact  
state, in which the contact terminal is pushed down by  
the circuit board, when the detachable unit holding the  
circuit board in the holder is inserted into the apparatus  
main body; and  
the contact terminal returns from the contact state to the  
initial state when the detachable unit holding the circuit  
board in the holder is withdrawn from the apparatus  
main body.
6. The image forming apparatus of claim 1, wherein the  
contact terminal includes:  
a fixed end fixed to the apparatus main body, the fixed end  
being formed on a rear end side in the insertion  
direction;  
a free end formed on a tip end side opposite to the rear end  
side in the insertion direction; and  
an apex part formed between the fixed end and the free  
end, the apex part being formed by bending a plate  
member into L-shape.
7. The image forming apparatus of claim 1, wherein the  
detachable unit is a developer cartridge containing a devel-  
oper.
8. The image forming apparatus of claim 1, wherein the  
detachable unit is an image forming unit including an image  
carrier on which an electrostatic latent image is formed.
9. The image forming apparatus of claim 1, wherein the  
detachable unit is a fixing unit which fixes a developer image  
onto a recording medium.
10. The image forming apparatus of claim 1, wherein:  
the holder includes a second positioning member which  
positions a rear end of the circuit board in the insertion  
direction, the rear end being opposite to the tip end;  
a recess is formed between the first positioning member  
and the second positioning member; and  
bottom faces of the slit parts and the recess are on a same  
level in height.
11. A detachable unit configured to be inserted into and to  
be withdrawn from an image forming apparatus that  
includes a guide section and a contact terminal as a spring,  
a state of the detachable unit being changed to an attached  
state by inserting the detachable unit along the guide section  
in an insertion direction, the state of the detachable unit  
being changed to a detached state by withdrawing the  
detachable unit along the guide section in a withdrawal  
direction opposite to the insertion direction, the detachable  
unit comprising:  
a unit main body; and  
a holder provided on the unit main body, the holder being  
configured to hold a circuit board including an electro-  
de terminal which comes into contact with the  
contact terminal, wherein  
the holder includes a first positioning member for posi-  
tioning a tip end of the circuit board in the insertion  
direction when the detachable unit holding the circuit  
board in the holder is slid along the guide section to be  
inserted in the insertion direction; and  
the first positioning member forms two slit parts through  
which the contact terminal passes when the detachable  
unit not holding the circuit board in the holder in the  
attached state is slid in the withdrawal direction.
12. The detachable unit of claim 11, wherein the holder  
includes a second positioning member which positions a rear

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- end of the circuit board in the insertion direction, the rear  
end being opposite to the tip end; and  
a recess formed between the first positioning member and  
the second positioning member; and  
at least a part of the contact terminal is located in the  
recess when the detachable unit not holding the circuit  
board in the holder is in the attached state.
13. The detachable unit of claim 11, wherein the electrode  
terminal is a tabular electrode parallel to the insertion  
direction.
14. The detachable unit of claim 11, wherein  
the holder includes a second positioning member which  
positions a rear end of the circuit board in the insertion  
direction, the rear end being opposite to the tip end;  
a recess is formed between the first positioning member  
and the second positioning member; and  
bottom faces of the slit parts and the recess are on the  
same level in height.
15. An image forming apparatus comprising:  
an apparatus main body including a guide section and a  
contact terminal as a spring;  
a detachable unit including a holder for holding a circuit  
board having an electrode terminal which comes into  
contact with the contact terminal, a state of the detach-  
able unit being changed to an attached state by inserting  
the detachable unit along the guide section in an  
insertion direction, the state of the detachable unit  
being changed to a detached state by withdrawing the  
detachable unit along the guide section in a withdrawal  
direction opposite to the insertion direction;  
a base plate including a first face and a second face  
opposite to the first face, the base plate supporting the  
contact terminal on the first face;  
a signal cable connected to the contact terminal; and  
a cable guide, along which the signal cable extends from  
the first face to the second face, wherein:  
the holder includes a first positioning member for posi-  
tioning a tip end of the circuit board in the insertion  
direction when the detachable unit holding the circuit  
board in the holder is slid along the guide section to be  
inserted in the insertion direction; and  
the first positioning member forms a slit part through  
which the contact terminal passes when the detachable  
unit not holding the circuit board in the holder in the  
attached state is slid in the withdrawal direction.
16. The image forming apparatus of claim 15, wherein the  
base plate includes an L-shaped notch as a part of the cable  
guide.
17. The image forming apparatus of claim 16, wherein the  
base plate includes a hook which prevents the signal cable  
from coming out of the L-shaped notch.
18. The image forming apparatus of claim 15, wherein the  
base plate includes a through hole as a part of the cable  
guide.
19. The image forming apparatus of claim 15, wherein:  
the base plate further includes an angle connector which  
electrically connects the contact terminal and the signal  
cable; and  
the angle connector includes a slot configured to be  
inserted by the signal cable, the slot facing the insertion  
direction.